ISOLATION AND IDENTIFICATION OF FUNGI ASSOCIATED WITH THE RHIZOSPHERE AND RHIZOPLANE OF WILD AND CULTIVATED PLANTS OF PAKISTAN

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ABSTRACT

Fifty-seven species of fungi belonging to 23 genera were isolated and identified from the rhizosphere and rhizoplane of 65 plant species, belonging to 58 genera and 19 families from Sindh and Baluchistan, (Pakistan). A greater number of fungi were isolated from the rhizosphere than from the rhizoplane. In the rhizosphere, *Fusarium solani* and *Aspergillus* spp. were dominant followed by *Drechslera australiensis*. In the rhizoplane, *Fusarium solani* was also dominant. Biocontrol agents like *Trichoderma harzianum*, *T. koningii*, *T. viride*, *V. chlamydosporium*, and *Stachybotrys atra* were isolated in low frequency suggesting their poor competence in the rhizosphere. *Memnoniella echinata* from *Zea mays* and *Sorghum bicolor* and *Stachybotrys parvispora* from *Zea mays* were reported for the first time from Pakistan. Microorganisms in agricultural soils are known to exert profound influences on the soil fertility status as well as on the suppression of soil-borne plant diseases. Multiple microbial interactions involving bacteria and fungi in the rhizosphere are shown to provide enhanced biocontrol in many cases in comparison with biocontrol agents used singly. Importantly, a soil that is suppressive to one pathogen is not necessarily suppressive to another, and so specificity in soil-plant-microbe interactions for disease suppression exists. Modern methods for analyzing microbial community structures may prove particularly valuable to help define the key organisms or groups of organisms responsible for such natural suppression as well as for monitoring the spread and impact of introduction of specific biocontrol agents or other management practices on natural microbial populations.

RESUMEN

Cincuenta y cinco especies de hongos pertenecientes a 23 géneros, fueron aisladas e identificadas en la rizosfera y rizoplana de 65 especies vegetales, pertenecientes a 58 géneros y 19 familias de Sindh y Baluchistan. (Pakistán). Fue aislado un número mayor de hongos en la rizosfera que en el rizoplana. En la rizosfera, *Fusarium solani* y *Aspergillus* spp. fueron los dominantes seguidos de *Drechslera australiensis*. En el rizoplana, *Fusarium solani* fue dominante también. Agentes de biocontrol como *Trichoderma harzianum*, *T. koningii*, *T. viride*, *V. chlamydosporium*, y *Stachybotrys* se aislaron en baja frecuencia lo que sugiere una competencia pobre en la rizosfera. *Memnoniella echinata* de *Zea mays* y *Sorghum bicolour*, y *Stachybotrys parvispora* de *Zea mays* se citan por primera vez de Pakistán. Los microorganismos de los suelos agrícolas ejercen profundas influencias en la fertilidad del suelo así

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como en la supresión de enfermedades de las plantas originadas en el suelo. Las interacciones microbianas múltiples que implican bacterias y hongos en la rizosfera se ve que ejercen un biocontrol incrementado en muchos casos en comparación con los agentes de biocontrol usados aisladamente. Es importante, que un suelo que es supresivo para un patógeno no es necesariamente supresivo para otro, y así la especificidad en las interacciones suelo-planta-microbio para la supresión de la enfermedad existe. Los métodos modernos para analizar la estructuras de la comunidad microbiana pueden ser muy valiosos para ayudar a definir los organismos clave o grupos de organismos responsables de tal supresión natural así como para la supervisión de la extensión y el impacto de la introducción de agentes de biocontrol específicos u otras prácticas de gestión de poblaciones microbianas naturales.

INTRODUCTION

The rhizosphere has become an important area to test and evaluate new opportunities being developed in biotechnology. The rhizosphere is the portion of soil directly influenced by substances issuing from roots into the soil solution, favoring certain microorganisms, harmful around roots of unthrifty plants and beneficial around roots of healthy plants (Atkinson & Watson 2000; Curl 1982). There is an exchange of materials between the plant root and the surrounding micro-population within the rhizosphere. These materials may inhibit or promote growth of the plant or the microorganisms (Bazin et al. 1990; Filion et al. 2004; Katan 2002). Rhizosphere is therefore the site where biological control of soilborne pathogens takes place. Pathogen population (inoculum density), growth and survival and infection or pathogenesis are all influenced by the rhizosphere (Abawi & Widmer 2000; Curl & Truelove 1986; Manka & Kacprzak 1999). Infection of roots by a soilborne plant pathogen is influenced by the physical and chemical properties of the rhizosphere environment and interaction of the pathogen with other microorganisms in that environment (Dix & Webster 1995; Tate 1995). Saprophytic fungi and bacteria in the rhizosphere and root surface create a competitive deterrent to the colonization of rhizoplane and invasion of the plant roots by pathogens (Abawi & Widmer 2000; Tate 1995). It has been reported that more competitive fungal species are found in rhizosphere than soil away from roots (Tate 1995).

Another special habitat or site of microbial activity is rhizoplane or the root surface which supports relatively high biologic activity than rhizosphere (Abawi & Widmer 2000; Atkinson & Watson 2000). It has been reported that legumes support larger rhizosphere population than non-leguminous plants (Subba Rao 1977). Similarly, rhizosphere of resistant cultivars of pigeon-pea (*Cajanus cajan*) harbored more *Streptomyces* and *Trichoderma* antagonistic to *Fusarium udum* causal agent of pigeon pea wilt, than susceptible cultivars and *Trichoderma viride* in the rhizosphere of varieties of tomato resistant to *Verticillium* wilt (Subba Rao 1977). *Trichoderma* spp. and *Paecilomyces lilacinus* are known as effective biocontrol agents against root infecting fungi and have shown promising results in microplot experiments (Boland & Kuykendall 1998; Burges 1998; Lewis et al. 1998; Whipps 1997, 2001). The opportunity to improve crop productivity by introduc-

TABLE 1. Some of the soil characteristics of the collection sites.

Province/Location	Soil Type	Soil pH
Sindh Province		
Darsano Chano	Surface and sub-surface of soil sandy loam	8.0–8.2
Gharo	Surface and sub-surface of soil clay loam	8.2–8.5
Karachi University Campus	Surface and sub-surface of soil silty loam	8.0–8.1
Kathor	Surface coarse sand and sub-surface sandy loam	8.0–8.05
Memon Goth	Surface and sub-surface of soil silty-sandy loam	8.05–8.1
Shah Faisal Colony	Surface and sub-surface of soil sandy loam	8.0–8.1
Thatta	Surface and sub-surface of soil clay loam	8.3–8.5
Baluchistan Province		
Hub	Surface and sub-surface of soil sandy loam	8.0–8.2

ing organisms to the rhizosphere is highlighting a major need for the study of fungal community on and around the roots of plants. The present report describes the occurrence of fungal species on rhizosphere and rhizoplane of different plant species collected from different parts of Sindh and Baluchistan (Pakistan).

MATERIALS AND METHODS

Sites and Collection of Samples

Eight sites were chosen for the collection of samples; seven from Sindh and one from Baluchistan. Details of collection sites along with some of the soil characteristics are provided in Table 1. Overall rainfall of these areas is very scanty ranging from 25mm to 102 mm per year. Average summer temperature is 50° C (maximum) and 25° C (minimum), and average winter temperature 25° C (maximum) and 8° C (minimum).

Young healthy plants were carefully dug out up to a depth of 15 cm and root samples with adhering soil (25–50 g depending upon root size) were collected in polyethylene bags. Roots of cultivated crops were collected from agricultural fields. Roots of wild plants were collected from adjacent uncultivated fellow fields. Five replicates of each plant species were collected from each location. Samples were kept under refrigeration at 4° C until the isolation of fungi made within 24 hours. Potato dextrose agar was used for the isolation of fungi in this study, since it supports the growth of most of the fungi from rhizoplane and rhizosphere (van Elsas et al. 2002) and also for endophytes (Halleen et al. 2003), except obligate parasites and those which have special growth requirements.

Isolation of Fungi from Rhizosphere

Volume displacement technique was used for the isolation of fungi from rhizosphere soil as described by Reyes and Mitchell (1962). Root pieces with adhering soil were placed in a graduated cylinder containing 18 mL sterilized distilled water and shaken vigorously. The roots were removed and the process was repeated

Table 2. Fungi isolated from rhizoplane and rhlosphere of wild and cultivated plants growing in Sindh and Baluchistan, Pakistan.

No and Host	Rhizoplane	Location	Rhizosphere	Location
AMARANTHACEAE				
1. *Amaranthus virides* L.	*Alternaria alternata* (Fr.) Keissler	4	*Alternaria alternata* (Fr.) Keissler	4,6
	Aspergillus flavus Link ex Gray	4,5	*Aspergillus flavus* Link ex Gray	4,5
	A.fumigatus Fres.	4	*A.fumigatus* Fres.	2
	A. niger van Tieghem	4,5	*A. nidulans* (Eidam) Winter	5
	A. nidulans (Eidam) Winter	5	*A. niger* van Tieghem	5
	A.terreus Thom	4	*A. terreus* Thom	2,4,5,6
	Chaetomium indicum Corda	2,6	*Chaetomium indicum* Corda	2,6
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5,6	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	2,4,6
	Macrophomina phaseolina (Tassi) Goid.	2	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5,6
	Rhizopus stolonifer (Ehrenb.ex Link) Lind.	5	*F. oxysporum* Schlecht emend. Snyd & Hans.	4
	Unidentified black sterile mycelium	2,4	*Penicillium crysogenum* Thom.	4
			P rugulosum Thom	2
			Trichoderma viride Pers. ex Gray	4,5
			Unidentified black sterile mycelium	2,4
			Unidentified yellow sterile mycelium	2,4
2. *Aerva javanica* (Burm. f.) Merrill	*Alternaria alternata* (Fr.) Keissler	5	*Aspergillus flavus* Link ex Gray	5
	Aspergillus flavus Link ex Gray	5	*A. niger* van Tieghem	5
	A. niger van Tieghem	5	*A. terreus* Thom	5
	Fusarium oxysporum Schlecht emend. Snyd.& Hans	5	*Cunninghamella echinulata* (Thaxt.) Thaxt.	5
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5
	Rhizoctonia solani Kuhn	5	*Penicillium luteum* Zukel	5
3. *Digera muricata* (L.) Mart.	*Aspergillus flavus* Link ex Gray	1	*Alternaria alternata* (Fr.) Keissler	1
	A. niger van Tieghem	1	*Aspergillus flavus* Link ex Gray	1

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	A. terreus Thom	1	*A. niger* van Tieghem	1
	Fusarium solani (Mart.) Appel & Wollenw.		*A. terreus* Thom	1
	emend. Snyd. & Hans	1	*Cladosporium* sp.	1
	Macrophomina phaseolina (Tassi) Goid	1	*Fusarium culmurum* (W.G. Sm.) Sacc.	1
	Penicillium waksmanni Zaleski	1	*Myrothecium cinctum* (Corda) Sacc.	1
			Penicillium waksmanni Zaleski	1
ASCLEPIADACEAE				
4. *Calotropis procera* (Ait.) Ait.f. (ROOSTER TREE)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Aspergillus flavus Link	2	*Aspergillus flavus* Link	2,5
	A. niger van Tieghem	2	*A. niger* van Tieghem	2,5
	A. terreus Thom	2	*A. terreus* Thom	2,5
	Cunninghamella echinulata (Thaxt.) Thaxt.	2	*Cephalosporium* sp.	2
	Fusarium solani (Mart.) Appel & Wollenw.		*Chaetomium flavum* Omvik	2
	emend. Snyd. & Hans	2		
	Trichoderma viride Pers. ex Gray	2		
BORAGINACEAE				
5. *Heliotropium europeam* L. (EUROPEAN HELIOTROPE)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Aspergillus flavus Link ex Gray	2,6	*Aspergillus flavus* Link ex Gray	2,6
	A. nidulans (Eidam) Winter	2	*A. fumigatus* Fres.	2,6
	A. niger van Tieghem	2,6	*A. nidulans* (Eidam) Winter	2
	Chaetomium indicum Corda	2	*A. terreus* Thom	2
	Drechslera australiensis (Bugni) Subram.		*Cephalosporium* sp.	2
	& Jain ex M.B.Ellis.	6	*Chaetomium indicum* Corda	2
	D. hawaiiensis (Bugni) Subram.		*Cunninghamella echinulata* (Thaxt.) Thaxt.	2
	& Jain ex M.B. Ellis	2	*Drechslera australiensis* (Bugni) Subram.	
	D. halodes (Drechslera) Subram.		& Jain ex M.B. Ellis	6
	Fusarium solani (Mart.) Appel & Wollenw.		emend. Snyd. & Hans	2,6
	& Jain ex M.B. Ellis	2	*Fusarium solani* (Mart.) Appel & Wollenw.	

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	emend. Snyd. & Hans	2,6	*Penicillium luteum* Zukal	2
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	2	Unidentified sclerotial fungus	2
	Unidentified sclerotial fungus	2	Unidentified white sterile mycelium	2,6
CANNACEAE				
6. *Canna indica* L. (COMMON LILLY)	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	1	*Alternaria alternata* (Fr.) Keissler	1
	Fusarium oxysporum Schlecht emend. Snyd. & Hans.	1	*Aspergillus flavus* Link	1
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*A. niger* van Tieghem	1
	Macrophomina phaseolina (Tassi) Goid	1	*A. sulphureus* (Fres.) Thom & Church	1
			Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	1
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1
			Macrophomina phaseolina (Tassi) Goid	1
			Penicillium luteum Zukal	1
CARICACEAE				
7. *Carica papaya* L. (PAPAYA)	*Aspergillus flavus* Link ex Gray	2	*Aspergillus flavus* Link ex Gray	2
	A. niger van Tieghem	2	*A. glaucus* Link	2
	A. nidulans (Eidam) Winter	2	*A. niger* van Tieghem	2
	A. terreus Thom	2	*A. nidulans* (Eidam) Winter	2
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	2	*A. terreus* Thom	2
			Penicillium luteum Zukal	2
			Trichoderma harzianum Rifai	2
CHENOPODIACEAE				
8. *Beta vulgaris* L. (SUGAR BEET)	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis	3	*Alternaria alternata* (Fr.) Keissler	6
	Fusarium solani (Mart) Appel & Wollenw. emend. Snyd. & Hans	3,6	*Aspergillus flavus* ex Gray	3,6
	Macrophomina phaseolina (Tassi) Goid.	3,6	*A. niger* van Tieghem	3,6
			Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	6

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Rhizoctonia solani Kuhn	3,6	*Fusarium solani* (Mart) Appel & Wollenw. emend. Snyd. & Hans	6
9. *Chenopodium album* L. (PIGWEED)	*Alternaria alternata* (Fr.) Keissler	7	*Alternaria alternata* (Fr.) Keissler	7
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	7	*Aspergillus flavus* Link ex Gray	7
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7	*A. niger* van Tieghem	7
			A. terreus Thom	7
			Chaetomium globosum Kunze ex Steud.	7
			C. indicum Corda	7
			Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	7
			Fusarium semitectum Berk. & Rav.	7
			F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7
			Penicillium rugulosum Thom	7
10. *Spinacea oleracea* L. (SPINACH)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2,6
	Cunninghamella echinulata (Thaxt.) Thaxt.	2	*Aspergillus niger* van Tieghem	2,6
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis	2,6	*A. terreus* Thom	2
			Cladosporium sp.	2
	Fusarium oxysporum Schlecht. emend. Synd. & Hans	2	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis.	2,6
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,6	*Fusarium oxysporum* Schlecht. emend. Snyd & Hans	2
	Macrophomina phaseolina (Tassi) Goid.	2,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,6
	Rhizoctonia solani Kuhn	2,6	*Rhizoctonia solani* Kuhn	2
			Unidentified white sterile mycelium	2,6
COMPOSITAE				
11. *Conyza bonariensis* (L.) Cronquist	*Alternaria alternata* (Fr.) Keissler	5	*Aspergillus flavus* Link ex Gray	5
	Aspergillus flavus Link ex Gray	5	*A. niger* van Tieghem	5

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	A. niger van Tieghem	5	*A. terreus* Thom	5
	A. terreus Thom	5		
	Cunninghamella echinulata (Thaxt.) Thaxt.	5		
	Rhizopus stolonifer (Ehrenb.ex Link) Lind	5		
12. *Helianthus annuus* L. (SUNFLOWER)	*Alternaria alternata* (Fr.) Keissler	1,8	*Aspergillus flavus* Link ex Gray	1,8
	Drechslera australiensis (Bugni) Subram.& Jain ex M.B.Ellis.	1,8	*A. niger* van Tieghem	1,8
			A. terreus Thom	1
	Fusarium oxysporum Schlecht emend. Snyd. & Hans	1,8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8	*Macrophomina phaseolina* (Tassi) Goid	1,8
	Macrophomina phaseolina (Tassi) Goid	1,8	*Pencillium luteum* Zukal	1
	Rhizoctonia solani Kuhn	1,8	Unidentified white sterile mycelium	2
	Unidentified white sterile mycelium	1		
13. *Lactuca sativa* L. (LETTUCE)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Fusarium oxysporum Schlecht. emend. Snyd. & Hans	2	*Aspergillus flavus* Link ex Gray	2,6
			A. niger van Tieghem	2,6
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,6	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,6
	Macrophomina phaseolina (Tassi) Goid	2,6		
	Rhizoctonia solani Kuhn	2,6		
14. *Launea nudicaulis* Hook. f.	*Aspergillus niger* Van Tieghem	1	*Aspergillus flavus* Link ex Gray	1
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*A. niger* van Tieghem	1
			A. nidulans (Eidam) Winter	1
	Macrophomina phaseolina (Tassi) Goid.	1	*A. terreus* Thom	1
	Rhizoctonia solani Kuhn	1	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	1
	Unidentified black sterile mycelium	1,2		

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
			Fusarium semitectum Berk. & Rav.	1
			F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1
			Macrophomina phaseolina (Tassi) Goid.	1
			Unidentified black sterile mycelium	1,2
CONVOLVULACEAE				
15. *Convolvulus arvensis* L.	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	1,2
	Aspergillus flavus Link ex Gray	1,7	*Aapergillus flavus* Link ex Gray	1
	A. niger van Tieghem	1,2,7	*A. niger* van Tieghem	1
	Cunninghamella echinulata (Thaxt.) Thaxt.	2	*A. nidulans* (Eidan) Winter	2
	Cladosporium sp.	1,2	*A. sulphureus* (Fres.) Thom & Churh	1
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*A. terreus* Thom	1,2
	F. oxysporum Schlecht. emend. Snyd. & Hans	2	*Cladosporium* sp.	1,2
	Macrophomina phaseolina (Tassi) Goid.	1	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2
	Rhizoctonia solani Kuhn	7	*F. oxysporum* Schlecht. emend. Snyd. & Hans	2
	Rhizopus stolonifer (Ehrenb.ex Link) Lind.	2	*Macrophomina phaseolina* (Tassi) Goid.	1
			Rhizoctonia solani Kuhn	7
			Unidentified sterile fungus	7
CRUCIFERAE				
16. *Brassica juncea* (L.) Czern. & Coss (MUSTARD)	*Fusarium solani* (Mart) Appel & Wollenw. emend. Snyd.& Hans	7,8	*Alternaria alternata* (Fr.) Keissler	7
	Macrophomina phaseolina (Tassi) Goid	8	*Aspergillus niger* van Tieghem	7
	Rhizoctonia solani Kuhn	7,8	*Drechslera .australiensis* (Bugni) Subram. & Jain ex M.B.Ellis.	7
			Fusarium solani (Mart) Appel & Wollenw. emend. Snyd. & Hans	7
17. *Brassica oleracea* L. var. *capitata* L. (CABBAGE)	*Aspergillus flavus* Link ex Gray	4	*Aspergillus flavus* Link ex Gray	4
	A. terreus Thom	4	*A. terreus* Thom	4

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Chaetomium globosum Kunze ex Staud.	3	*Chaetomium globosum* Kunze ex Staud.	3
	Cunninghamella echinulata (Thaxt.) Thaxt.	4	*Cunninghamella echinulata* (Thaxt.) Thaxt.	4
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd & Hans	3,4	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd.& Hans	4
	Macrophomina phaseolina (Tassi) Goid.	3,4	*Macrophomina phaseolina* (Tassi) Goid.	3
	Rhizoctonia solani Kuhn	3	*Penicillium waksmanni* Zaleski	4
18. *Brassica rapa* L. (Rapifera group) (TURNIP)	*Curvalaria lunata* (Wakker) Boedijn	7	*Alternaria alternata* (Fr.) Keissler	7
	Fusarium. oxysporum Schlecht emend. Snyd & Hans.	7	*Fusarium solani* (Mart) Appel & Wollenw. emend. Synd. & Hans.	7
	F. solani (Mart.) Appel & Wollenw. emend. Snyd.& Hans	7	*Paecilomyces varioti* Bain	7
	Rhizoctonia solani Kuhn	7	Unidentified sterile mycelium	7
19. *Raphanus sativus* L. (RADISH)	*Alternaria alternata* (Fr.) Keissler	4	Unidentified yeast	7
	Aspergillus nidulans (Eidam) Winter	4	*Alternaria alternata* (Fr.) Keissler	4
	A. niger van Tieghem	4	*Aspergillus flavus* Link ex Gray	6
	Drechslera australiensis (Bugni) Subram.& Jain ex. M.B.Ellis	6	*A. nidulans* (Eidam) Winter	4
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4,6	*A. niger* van Tieghem	6
	Macrophomina phaseolina (Tassi) Goid.	6	*Cladosporium* sp.	4
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	4	*Drechslera australiensis* (Bugni) Subram.& Jain ex. M.B.Ellis	6
	Rhizoctonia solani Kuhn	6	*Fusarium oxysporum* Schlecht. emend. Snyd. & Hans	4
			F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4
			Macrophomina phaseolina (Tassi) Goid.	6
CUCURBITACEAE				
20. *Citrullus lanatus* (Thunb.) Matsum. & Nakai (WATERMELON)	*Aspergillus nidulans* (Eidam) Witner	5	*Articulospora* sp.	5
	A. niger van Tieghem	5	*Aspergillus flavus* Link ex Gray	5
	Drechslera hawaniesis (Bugni) Subram. & Jain		*A. glaucus* Link	5

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	ex M.B.Ellis.	5	*A. nidulans* (Eidam) Witner	5
	Fusarium oxysporum Schlecht. emend.		*A. niger* van Tieghem	5
	Snyd. & Hans.	5	*A. terreus* Thom	5
	F. solani (Mart.) Appel & Wollenw. emend.		*Cephalosporium* sp.	5
	Snyd. & Hans	5	*Drechslera hawaiiensis* (Bugni) Subram. & Jain ex M.B. Ellis	5
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5
			Myrothecium cinctum Tode	
			Paecilomyces lilacinus (Thom) Samson	5
			Penicillium javanicum Van Beijma	5
			Scopulariopsis brumptii Salvanet-Duval	5
			Trichoderma viride Pers. ex Grey	5
21. *Cucumis sativus* L. (CUCUMBER)	*Fusarium solani* (Mart.) Appel & Wollenw. emend.		*Alternaria alternata* (Fr.) Keissler	7
	Snyd. & Hans	7	*Aspergillus niger* van Tieghem	7
	Rhizoctonia solani Kuhn	7	*A. terreus* Thom	7
	Unidentified sterile fungus	7	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7
			Unidentified sterile mycelium	7
22. *Cucurbita moschata* L. (PUMPKIN)	*Chaetomium globosum* Kunze ex. Staud.	7	*Aspergillus flavus* Link ex Gray	7
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	7	*A. niger* van Tieghem	7
			Chaetomium globosum Kunze ex. Staud.	7
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,7	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7
	Macrophomina phaseolina (Tassi) Goid.	1,7		
	Rhizoctonia solani Kuhn	1,7		
23. *Lagenaria siceraria* (Mol.) Standl. (BOTTLE GOURD)	*Aspergillus flavus* Link ex Gray	1,2,5	*Aspergillus flavus* Link ex Gray	1,2,5
	A. niger van Tieghem	1,2,5	*A. niger* van Tieghem	1,2,5

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Chaetomium indicum Corda	2	*A. nidulans* (Eidam) Winter	5
	Curvularia lunata (Wakker) Boedijn	1	*A. sulphureus* (Fres.) Thom. & Church	5
	Cunninghamella echinulata (Thaxt.) Thaxt.	5	*A. terreus* Thom	2,5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,5	*Fusarium moniliforme* Sheld	2
	Macrophomina phaseolina (Tassi) Goid	1,5	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,5
	Rhizoctonia solani Kuhn	1	*Myrothecium roridum* Tode	5
	Paecilomyces lilacinus (Thom) Samson	5		
24. *Luffa aegyptiaca* Mill. (SPONGE GOURD)	*Chaetomium indicum* Corda	2,6	*Aspergillus flavus* Link ex Gray	2,5,6
	Curvularia lunata (Wakker) Boedijn	2,6	*A. fumigatus* Fres.	5
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	2,5,6	*A. nidulans* (Eidam) Winter	2,5,6
			A. niger van Tieghem	2,5,6
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5,6	*A. terreus* Thom	2,5,6
			Chaetomium indicum Corda	5
	Macrophomina phaseolina (Tassi) Goid.	2,6	*Cunninghamella echinulata* (Thaxt.) Thaxt.	5
	Paecilomyces lilacinus (Thom) Samson	5	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	5
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	5		
	Rhizoctonia solani Kuhn	2,6	*Fusarium moniliforme* Sheld	2
	Unidentified white sterile mycelium	2,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5,6
			Macrophomina phaseolina (Tassi) Goid.	2,6
			Paecilomyces lilacinus (Thom) Samson	5
			Penicillium purpurogenum Stoil	2
			Trichoderma viride Pers.ex Gray	2
			Unidentified sclerotial fungus	2
			Unidentified white sterile mycelium	6
			Unidentified yeast	6

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
25. *Momordica charantia* L. (Bitter gourd)	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*Aspergillus candidus* Link ex Link	2
	Macrophomina phaseolina (Tassi) Goid.	2	*A. niger* van Tieghem	2
	Rhizoctonia solani Kuhn	2	*Chaetomium indicum* Corda	2
			Drechslera australiensis (Bugni) Subram & Jain ex M.B.Ellis	2
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2
			Penicillium funiculosum Thom	2
CYPERACEAE				
26. *Cyperus rotundus* L.	*Aspergillus flavus* Link ex Gray	1,5	*Alternaria alternata* (Fr.) Keissler	5
	A. niger van Tieghem	5	*Aspergillus flavus* Link ex Gray	1,5
	Chaetomium globosum Kunze ex Staud	1,5	*A. niger* van Tieghem	5
	Cunninghamella echinulata (Thaxt.) Thaxt.	5	*A. terreus* Thom	5
	Drechslera australiensis (Bugni) Subram. & Jain ex. M.B. Ellis	5	*Drechslera australiensis* (Bugni) Subram. & Jain ex. M.B. Ellis	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd.& Hans.	5	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd.& Hans	1,5
			Trichoderma viride Pers. ex Gray	5
EUPHORBIACEAE				
27. *Euphorbia hirta* L.	*Aspergillus niger* van Tieghem	5	*Aspergillus flavus* Link ex Gray	5
	Cunninghamella echinulata (Thaxt.) Thaxt.	5	*A. niger* van Tieghem	5
	Drechslera australiensis (Bugni) Subram. & Jain ex. M.B. Ellis	5	*A. terreus* Thom	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd.& Hans.	5		
	Macrophomina phaseolina (Tassi) Goid.	5		
	Penicillium purpurogenum Stoll	5		

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
FABACEAE				
28. *Alhaji murorum* Medik	*Drechslera halodes* (Drechlera) Subram. & Jain	7	*Aspergillus flavus* Link ex Gray	7,8
	Fusarium solani (Mart) Appel & Wollenw. emend. Snyd. & Hans	7,8	*A. niger* van Tieghem	7,8
29. *Arachis hypogaea* L. (PEANUT)	*Chaetomium indicum* Corda	1	*Aspergillus flavus* Link ex Gray	1
	Curvalaria clavata (Wakker) Boedijn	1	*A. nidulans* (Eidam) Winter	1
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	1	*A. niger* van Tieghem	1
			A. terreus Thom	1
	Fusarium oxysporum Schlecht emend. Snyd. & Wollenw	1	*Fusarium oxysporum* Schlecht emend.. Snyd.& Wollenw	1
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1
	Macrophomina phaseolina (Tassi) Goid.	1	*Penicillium rugulosum* Thom	2
	Nigrospora oryzae (Berk. & Br.) Petch	1	Unidentified yellow sterile mycelium	2
	Rhizoctonaia solani Kuhn	1	Unidentified white sterile mycelium	1
	Unidentified yellow sterile mycelium	2		
	Unidentified white sterile mycelium	1		
30. *Cicer arietinum* L. (CHICKPEA)	*Chaetomium globosum* Kunze ex Steud.	8	*Aspergillus niger* van Tieghem	8
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	8	*A. terreus* Thom	8
			Chaetomium globosum Kunze ex Steud.	8
	D. halodes (Drechslera) Subram. & Jain	8	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	8
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hanse	8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hanse	8
	Macrophomina phaseolina (Tassi) Goid.	8		
31. *Cyamopsis tetragonoloba* (L.) Taub. (GUAR)	*Chaetomium globosum* Kunze ex Staud.	1	*Alternaria alternata* (Fr.) Keissler	6
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	1	*Aspergillus flavus* Link ex Gray	6
			A. niger van Tieghem	6

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Fusarium semitectum Berk. & Rav.	6	*Chaetomium globosum* Kunze ex Staud.	6
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans.	1,6	*Curvularia clavata* Jain	6
	Macrophomina phaseolina (Tassi) Goid.	1	*Fusarium semitectum* Berk. & Rav.	6
	Rhizoctonia solani Kuhn	1,4,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	6
	Unidentified white sterile mycelium	6	*Penicillium citrinum* Thom.	6
			Trichoderma viride Pers. ex Gray	6
			Unidentified white sterile mycelium	6
			Unidentified yeast	6
32. *Glycine max* (L.) Merr. (SOYBEAN)	*Alternaria alternata* (Fr.) Keissler	1,8	*Aspergillus flavus* Link ex Gray	1,8
	Aspergillus candidus Link	1	*A. niger* van Tieghem	1,8
	A. flavus Link ex Gray	1,8	*A. terreus* Thom	1,8
	A. niger van Tieghem	1,8	*Curvularia lunata* (Wakker) Boedijn	8
	A. terreus Thom	1,8	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	1,8
	Curvularia lunata (Wakker) Boedijn	8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	1,8	*Macrophomina phaseolina* (Tassi) Goid.	1,8
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8	*Monodictys putredinis* (Wallr.) Hughes	1
	Macrophomina phaseolina (Tassi) Goid.	1,8	*Myrothecium roridum* Tode	1
	Myrothecium roridum Tode	1	*Nigrospora oryzae* (Berk. & Br.) Petch	1
	Rhizoctonia solani Kuhn	1,8	*Penicillium purpurogenum* Stoll	1
			Trichoderma harzianum Rifai	1
			Unidentified Basidomycetes	1
33. *Lens culinaris* Medic (LENTIL)	*Alternaria alternata* (Fr.) Keissler	1,8	*Alternaria alternata* (Fr.) Keissler	2
	Curvularia lunata (Wakker) Boedijn	8	*Aspergillus flavus* Link ex Gray	1,8
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	8	*A. niger* van Tieghem	1,8
			A. terreus Thom	8

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	D. halodes (Drechslera) Subram. & Jain ex M.B. Ellis	8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8
	Fusarium oxysporum Schlecht emend. Snyd. & Hans.	8	Unidentified Basidomycetes	1
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8		
	Macrophomina phaseolina (Tassi) Goid.	1,8		
	Rhizoctonia solani Kuhn			
	Stachybotrys atra Corda	8		
	Unidentified Basidiomycetes	1		
34. *Leucaena leucocephala* (Lam.) de Wit (IPIL-IPIL)	*Aspergillus flavus* Link ex Gray	5	*Aspergillus flavus* Link ex Gray	5
	A. terreus Thom	5	*A. niger* van Tieghem	5
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	5	*A. nidulans* (Eidam) Winter	5
			A. sulphureus (Fres.) Thom. & Church.	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5	*A. terreus* Thom	5
	Helicocephalum sp.	5	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	5
35. *Medicago sativa* L. (ALFALFA)	*Alternaria alternata* (Fr.) Keissler	5,6	*Alternaria alternata* (Fr.) Keissler	5,6
	Aspergillus flavus Link ex Gray	5	*Aspergillus flavus* Link ex Gray	3,5,6
	A. niger van Tieghem	5	*A. niger* van Tieghem	3,5,6
	A. terreus Thom	5	*A. terreus* Thom	5,6
	Curvolaria lunata (Wakker) Boedijn	6	*Fusarium semitectum* Berk & Rav.	6
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	3,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3,6
	Fusarium semitectum Berk & Rav.	6	*Macrophomina phaseolina* (Tassi) Goid.	3,6
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5,6	Unidentified sclerotial fungus	3,6
			Unidentified white sterile mycelium	3

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Macrophomina phaseolina (Tassi) Goid.	3,6		
	Rhizoctonia solani Kuhn	3,6		
	Unidentified sclerotial fungus	3,6		
36. *Melilotus alba* Medik. (WHITE SWEET-CLOVER)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Aspergillus flavus Link ex Gray	2	*Aspergillus flavus* Link ex Gray	5
	A. fumigatus Fres.	2	*A. niger* van Tieghem	2,5
	A. niger van Tieghem	2	*A. terreus* Thom	2
	A. nidulans (Eidam) Winter	2	*Cephalosporium* sp.	2
	Chaetomium flavum Omvik	2	*Chaetomium flavum* Omvik	2
	Drechslera australiensis (Bugni) Subram & Jain ex M.B.Ellis.	2,5	*Drechslera australiensis* (Bugni) Subram & Jain ex M.B.Ellis.	5
	Fusarium oxysporum Schlecht. emend. Snyd. & Hans	2	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5	*F. oxysporum* Schlecht. emend. Snyd. & Hans	2
37. *Phaseolus vulgaris* L. (COMMON BEAN)	*Alternaria alternata* (Fr.) Keissler	4,6	*Alternaria alternata* (Fr.) Keissler	4,6
	Aspergillus niger van Tieghem	4	*Aspergillus niger* van Tieghem	4,6
	A. terreus Thom	6	*A. sulphureus* (Fres.) Thom. & Church.	6
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	6	*A. terreus* Thom	6
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4,6	*Cladosporium* sp.	4
	Macrophomina phaseolina (Tassi) Goid.	6	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	6
	Rhizoctonia solani Kuhn	4,6	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4,6
			Macrophomina phaseolina (Tassi) Goid.	6
			Rhizopus stolonifer (Ehrenb. ex Link) Lind.	4

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
			Scopulariopsis Brumptii Salvanet-Duval	4
			Trichoderma harzianum Rifai	6
			T. koningii Oudem	6
38. *Pisum sativum* L. (PEA)	*Alternaria alternata* (Fr.) Keissler	8	*Alternaria alternata* (Fr.) Keissler	8
	Chaetomium globosum Kunze ex. Staud	8	*Aspergillus flavus* Link ex Gray	8
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	8	*A. niger* van Tieghem	8
			Chaetomium globosum Kunze ex. Staud	8
	D.halodes (Drechslera) Subram. & Jain	8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	8
	Fusarium solani (Mart) Appel & Wollenw. emend. Snyd. & Hans	8		
	Macrophomina phaseolina (Tassi) Goid.	8		
39. *Sesbania sesban* (L.) Merr. (EUROPEAN RIVER HEMP)	*Aspergillus niger* van Tieghem	3	*Aspergillus flavus* Link ex Gray	3
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3	*A. niger* van Tieghem	3
			A. terreus Thom	3
	Unidentified yellow sterile mycelium	3	*Fusarium manoliforme* Sheld.	3
	Unidentified white sterile mycelium	3	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3
			Macrophomina phaseolina (Tassi) Goid	3
			Unidentified yellow sterile mycelium	3
			Unidentified white sterile mycelium	3
40. *Trifolium alexandrium* (L.) Spergue ex. Turrill (CLOVER)	*Alternaria alternata* (Fr.) Keissler	8	*Alternaria alternata* (Fr.) Keissler	8
	Chaetomium globosum Kunze ex. Staud.	8	*Aspergillus flavus* Link ex Gray	5,8
	Curvalaria lunata (Wakker) Boedijn	8	*A. niger* van Tieghem	5,8
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis	5,8	*A. terreus* Thom	5
			Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis.	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5,8	*Fusarium solani* (Mart.) Appel & Wollenw. emend.	

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Macrophomina phaseolina (Tassi) Goid.	5,8	Snyd. & Hans	5,8
	Rhizoctonia solani Kuhn	5,8	*Macrophomina phaseolina* (Tassi) Goid.	5,8
41. *Trigonella foenum-graecum* L. (FENUGREEK)	*Alternaria alternata* (Fr.) Keissler	2,7,8	*Alternaria alternata* (Fr.) Keissler	2
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,8	*Aspergillus flavus* Link ex Gray	2,8
			A. niger van Tieghem	2,8
	Macrophomina phaseolina (Tassi) Goid.	2,8	*A. terreus* Thom	8
	Rhizoctonia solani Kuhn	2	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,8
42. *Vigna mungo* (L.) Hepper (URID BEAN)	*Curvularia lunata* (Wakker) Boedijn	1	*Aspergillus flavus* Link ex Gray	1
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis	1	*A. niger* van Tieghem	1
			A. terreus Thom	1
	Fusarium solani (Mart.) Appel & Wollenw. emend Snyd. & Hans.	1	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis.	1
	Macrophomina phaseolina (Tassi) Goid.	1	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans.	1
	Rhizoctonia solani Kuhn	1		
43. *Vigna radiata* (L.) Wilczek (MUNG BEAN)	*Alternaria alternata* (Fr.) Keissler	1,8	*Alternaria alternata* (Fr.) Keissler	1
	Aspergillus niger van Tieghem	1	*Aspergillus flavus* Link ex Gray	1,8
	Chaetomium globosum Kunze ex Staud.	1,8	*A. fumigatus* Fres.	1
	Curvularia lunata (Wakker) Boedijn	8	*A. nidulans* (Eidam) Winter	1
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis.	1,8	*A. niger* van Tieghem	1
			A. terreus Thom	1,8
	D.halodes (Drechslera) Subram. & Jain	8	*Chaetomium globosum* Kunze ex Staud.	1,8
	Fusarium moniliforme Sheld.	8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8
	F.solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8	*Penicillium purpurogenum* Stoll	1
	Macrophomina phaseolina (Tassi) Goid.	1,8	*Macrophomina phaseolina* (Tassi) Goid.	1,8
	Rhizoctonia solani Kuhn	1,8	*Myrothecium roridum* Tode	1

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Unidentified Ascomycetes	1	Unidentified white sterile mycelium	2
	Unidentified white sterile mycelium	1		
GRAMINEAE				
44. *Avena sativa* L. (OAT)	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	5	*Aspergillus flavus* Link ex Gray	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5	*A. niger* van Tieghem	5
	Rhizoctonia solani Kuhn	5	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis	5
45. *Cenchrno setigerus* Vahl	*Aspergillus flavus* Link ex Gray	5	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5
	A. niger van Tieghem	5	*Aspergillus flavus* Link ex Gray	5
	A. terreus Thom	5	*A. niger* van Tieghem	5
	Cunninghamella echinulata (Thaxt.) Thaxt.	5	*A. terreus* Thom	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*Cunninghamella echinulata* (Thaxt.) Thaxt.	5
46. *Cynodon dactylon* (L.) Pers. (BERMUDA GRASS)	*Aspergillus flavus* Link ex Gray	2	*Curvularia clavata* Jain	5
	A. niger van Tieghem	2	*Paecilomyces lilacinus* (Thom) Samson	5
	A. terreus Thom	2	*Aspergillus candidus* Link	5
	Curvularia lunata (Wakker) Boedijn	1	*A. flavus* Link ex Gray	1,2,5
	Drechslera australiensis(Bugni) Subram. & Jain ex. M.B.Ellis	1	*A. niger* van Tieghem	1,2,5
	Fusarium proliferatum (Matsushima) Nirenberg	5	*A. nidulans* (Eidam) Winter	2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hanse	2	*A. terreus* Thom	2,5
	Macrophomina phaseolina (Tassi) Goid	2	*Cephalosporium* sp.	2
	Nigrospora oryzae (Berk.& Br.) Petch	1	*Chaetomium flavum* Omvik	5
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	2	*Cunninghamella echinulata* (Thaxt.) Thaxt.	2,5
			Curvularia lunata (Wakker) Boedijn	1
			Drechslera australiensis (Bugni) Subram. & Jain ex.M.B.Ellis	1
			Fusarium proliferatum (Matsushima) Nirenberg	5

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
			F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5
			Myrothecium roridum Tode	5
			Nigrospora oryzae (Berk.& Br.) Petch	1
			Paecilomyces lilacinus (Thom) Samson	5
			Rhizopus stolonifer (Ehrenb.ex Link) Lind.	5
47. *Oryzae sativa* L. (RICE)	*Chaetomium globosum* Kunze ex. Staud.	7	*Aspergillus flavus* Link ex Gray	7
	Curvularia lunata (Wakker) Boedijn	7	*A. niger* van Tieghem	7
	Drechslera hawaiiensis (Bugni) Subram. & Jain ex M.B. Ellis	7	*Chaetomium globosum* Kunze ex. Staud.	7
	Fusarium solani (Mart.) Appel & Wollenw. Emend. Snyd. & Hans	7	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7
	Macrophomina phaseolina (Tassi) Goid.	7		
48. *Pennisetum americanum* (L.) Leeve (MILLET)	*Alternaria alternata* (Fr.) Keissler	6	*Alternaria alternata* (Fr.) Keissler	6
	Aspergillus niger van Tieghem	5	*Aspergillus candidus* Link ex Link	2
	A. nidulans (Eidam) Winter	5	*A. flavus* Link ex Gray	2,5,6
	A. terreus Thom	5	*A. niger* van Tieghem	2,5
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	2	*A. terreus* Thom	5,6
	D. hawaiiensis (Bugni) Subram. & Jain ex M.B. Ellis.	5	*Drechslera australiensis* (Bugni) Subram. & Jain ex. M.B. Ellis	2
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,6	*Fusarium moniliforme* Sheld.	2
	Macrophomina phaseolina (Tassi) Goid.	1,2,6	*F. semitectum* Berk.& Rav.	6
	Rhizoctonia solani Kuhn	2,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,6
	Unidentified yellow sterile mycelium	1	*Macrophomina phaseolina* (Tassi) Goid.	1,2,6
			Monodictys putredinis (Wallr.) Hughes	1
			Penicillium rugulosum Thom	6

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
			Unidentified Ascomycetes	2
			Unidentified sclerotial fungus	1,2,6
			Unidentified yellow sterile mycelium	1
			Unidentified white sterile mycelium	1
49. *Setaria verticilata* (L.) Beauv. (HOOKED BRISTLE GRASS)	*Alternaria alternata* (Fr.) Keissler	1,4	*Alternaria alternata* (Fr.) Keissler	1,4
	Aspergillus flavus Link ex Gray	4	*Aspergillus flavus* Link ex Gray	4
	A. niger van Tieghem	4	*A. terreus* Thom	1,4
	A. terreus Thom	1,4	*A. nidulans* (Eidam) Winter	4
	Cladosporium sp.	1	*Cladosporium* sp.	1
	Curvularia clavata Jain	4	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	4
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	4	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4
	Rhizopus stolonifer (Ehrenb. ex Link) Lind	1	*Myrothecium cinctum* (Corda) Sacc.	1
50. *Sorghum bicolor* (L.) Moench. (SORGHUM)	*Curvularia clavata* Jain	3	*Aspergillus flavus* Link ex Gray	3
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Eilis.	3	*A. sulphureus* (Fres.) Thom. & Church	3
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3	*Curvularia clavata* Jain	3
	Macrophomina phaseolina (Tassi) Goid.	3	*Drechslera. australiensis* (Bugni) Subram. & Jain M.B.Ellis.	3
	Memnoniella echinata (Riv.) Galloway	3	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3
			Macrophomina phaseolina (Tassi) Goid.	3
			Memnoniella echinata (Riv.) Galloway	3
			Unidentified white sterile mycelium	3
51. *Triticum aestivum* L. (WHEAT)	*Alternaria alternata* (Fr.) Keissler	5,6	*Alternaria alternata* (Fr.) Keissler	6
	Chaetomium globosum Kunze ex. Staud.	5,6	*Aspergillus flavus* Link ex Gray	5,6
	Curvularia lunata (Wakker) Boedijn	6	*A. niger* van Tieghem	5,6

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis	5	*A. terreus* Thom	5
	Fusarium moniliforme Sheld.	6	*Chaetomium globosum* Kunze ex. Staud.	6
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans.	5,6	*Fusarium moniliforme* Sheld.	6
	Unidentified white sterile mycelium	5	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans.	5,6
			Penicillium rugulosum Thom	6
			Unidentified white sterile mycelium	5
52. *Zea mays* L. (CORN)	*Alternaria alternata* (Fr.) Keissler	2,6	*Alternaria alternata* (Fr.) Keissler	2,4,6
	Aspergillus flavus Link ex Gray	4	*Aspergillus flavus* Link ex Gray	1,2,4,6
	A. niger van Tieghem	2	*A. fumigatus* Fres.	1,2
	A. terreus Thom	2	*A. nidulans* (Eidam) Winter	1
	Cunninghamella echinulata (Thaxt.) Thaxt.	2	*A. sulphureus* (Fres.) Thom. & Church	1
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	1,2,6	*A. terreus* Thom	2,4,6
	D. halodes (Drechslera) Subram. & Jain	6	*Cephalosporium* sp.	2,4
	Fusarium moniliforme Sheld.	6	*Chaetomium indicum* Corda	2
	F. oxysporum Schlecht. emend. Snyd. & Hans	4	*Curvularia lunata* (Wakker) Boedijn	4
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,4,6	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	2
	Macrophomina phaseolina (Tassi) Goid.	1	*Fusarium moniliforme* Sheld.	2
	Rhizoctonia solani Kuhn	6	*F. oxysporum* Schlecht. emend. Snyd. & Hans	2,4
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	2,4,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,4,6
			Macrophomina phaseolina (Tassi) Goid.	1
			Penicillium purpurogenum Stoll	1
			Rhizopus stolonifer (Ehrenb. ex Link) Lind.	4
			Stachybotry parvispora Hughes	6
			Unidentified yeast	1,4

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
MALVACEAE				
53. *Abelmoschus esculentus* (L.) Moench (Okra)	*Alternaria alternata* (Fr.) Keissler	8	*Alternaria alternata* (Fr.) Keissler	7
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	7	*Aspergillus flavus* Link ex Gray	1,7,8
	Fusarium solani (Mart.) Appl & Wollenw. emend.Snyd. & Hans	1,7,8	*A. niger* van Tieghem	1,7,8
	Macrophomina phaseolina (Tassi) Goid.	1,7	*A. terreus* Thom	1,8
	Rhizoctonia solani Kuhn	1,7,8	*Drechslera australiensis* (Bugni) Subram. M.B.Ellis.	7
			Fusarium solani (Mart.)Appl & Wollenw. emend.Snyd. & Hans	1,7,8
54. *Abutilon indicum* (L.) Sweet (Monkey bush)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Aspergillus flavus Link ex Gray	2	*Aspergillus flavus* Link ex Gray	2
	A. niger van Tieghem	2	*A. nidulans* (Eidam) Winter	2
	A. terreus Thom	2	*A. niger* van Tieghem	2
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*A. terreus* Thom	2
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	2	*Cephalosporium* sp.	2
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2
			Macrophomina phaseolina (Tassi) Goid.	2
55. *Gossypium arboreum* L. (Cotton)	*Alternaria alternata* (Fr.) Keissler	1,8	*Aspergillus flavus* Link ex Gray	1,8
	Chaetomium globosum Kunze ex. Staud.	1	*A. niger* van Tieghem	1,8
	Curvularia lunata (Wakker) Boedijn	1	*A. terreus* Thom	1,8
	Drechslera australiensis (Bugni) Subram.& Jain ex M.B. Ellis.	1	*Fusarium oxysporum* Schlecht emend. Snyd. & Hans	1
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8
	Macrophomina phaseolina (Tassi) Goid.	8	*Penicillium luteum* Zukal	1
	Rhizoctonia solani Kuhn	1,8	*Trichoderma viride* Pers. ex Gray	1
	Trichoderma viride Pers. ex Gray	1	Unidentified sterile fungus	2
			Unidentified yeast	1

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
PEDELIACEAE				
56. *Sesamum indicum* L. (SESAME)	*Aspergillus niger* van Tieghem	5	*Aspergillus candidus* Link	5
	Curvularia lunata (Wakker) Boedijn	1	*A.flavus* Link ex Gray	1
	Cunninghamella echinulata (Thaxt.) Thaxt	5	*A.nidulans* (Eidam) Winter	1
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	1	*A. niger* van Tieghem	5
			A. sulphureus (Fres.) Thom. & Church.	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*A. terreus* Thom	5
	Rhizoctonia solani Kuhn	1	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis.	1
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1
			Paecilomyces lilacinus (Thom.) Samson	5
			Penicillium purpurogenum Stoll	1
			Rhizoctonia solani Kuhn	1
			Unidentified white sterile mycelium	1,2
PIPERACEAE				
57. *Piper betel* L. (BETEL)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Chaetomium globosum Kunze ex. Staud	2	*Aspergillus flavus* Link ex Gray	2
	Curvularia lunata (Wakker) Boedijn	2	*A. niger* van Tieghem	2
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	2	*Chaetomium globosum* Kunze ex. Staud	2
			Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	2
	Fusarium moniliforme Sheld	2	*Fusarium moniliforme* Sheld	2
	F. oxysporum Schlecht emend. Snyd & Hans.	2	*F. oxysporum* Schlecht emend. Snyd & Hans.	2
	F. semitectum Berk. & Rav.	2	*F. semitectum* Berk. & Rav.	2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2
	Macrophomina phaseolina (Tassi) Goid.	2		
	Rhizoctonia solani Kuhn	2		

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
SOLANACEAE				
58. *Capsicum annuum* L. (Pepper)	*Alternaria alternata* (Fr.) Keissler	1,2,6,7	*Alternaria alternata* (Fr.) Keissler	1,2,6,7
	Aspergillus flavus Link ex Gray	2	*Aspergillus flavus* Link ex Gray	2
	A. niger van Tieghem	1,2,6,7	*A. niger* van Tieghem	1,2,6,7
	A. nidulans (Eidam) Winter	1,2,6	*A. nidulans* (Eidam) Winter	1,2,6
	A. terreus Thom	2	*A. terreus* Thom	2
	Chaetomium indicum Corda	2	*Cephalosporium* sp.	2
	Curvularia clavata Jain	2	*Chaetomium indicum* Corda	2
	C. lunata (Wakker) Boedijn	7	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	2
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	2	*Fusarium culmurum* (W.G. Sm.) Sacc.	2
	Fusarium culmurum (W.G. Sm.) Sacc.	2	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,6,7
	F. oxysporum Schlecht emend. Snyd. & Hans	2,7	*Macrophomina phaseolina* (Tassi) Goid.	2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,6,7	*Penicillium funiculosum* Thom	1
	Macrophomina phaseolina (Tassi) Goid.	1,2	*P. rugulosum* Thom	2,6
	Rhizoctonia solani Kuhn	1,2	*Trichoderma harzianum* Rifai	2
	Trichoderma viride Pers. ex Gray	6	Unidentified black sterile mycelium	1,2
	Unidentified black sterile mycelium	1,2		
59. *Capsicum annuum* L. var. *shimla* (Pepper)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	7
	Aspergillus niger van Tieghem	1,2,6	*Aspergillus flavus* Link ex Gray	1,2
	A. terreus Thom	1,2	*A. niger* van Tieghem	2,7
	Fusarium moniliforme Sheld.	1,2,7	*A. terreus* Thom	1,2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,6,7	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	2
	Trichoderma viride Pers. ex Gray	2	*Fusarium moniliforme* Sheld	2

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Unidentified scleotial fungus	1	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,6,7
			Penicillium funiculosum Thom	1,7
			Trichoderma viride Pers. ex Gray	2
			Unidentified sclerotial fungus	1,2
60. *Lycopersicon esculentum* Mill. (TOMATO)	*Alternaria alternata* (Fr.) Keissler	1,2,5	*Alternaria alternata* (Fr.) Keissler	1,5
	Aspergillus niger van Tieghem	1	*Aspergillus niger* van Tieghem	1
	Cladosporium sp.	1	*A. candidus* Link ex Link	1
	Curvularia lunata (Wakker) Boedijn	1,2	*A. flavus* Link ex Gray	1,2,5,7
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	1	*A. niger* van Tieghem	1,2,5
			A. terreus Thom	1
	Fusarium moniliforme Sheld.	2	*Cladosporium* sp.	1
	F.oxysporum Schlecht. emend. Snyd. & Hans.	1,2	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	1
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*Fusarium oxysporum* Schlecht emend.snyd.&Hans	1
	Humicola grisea Traaen	5	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1
	Macrophomina phaseolina (Tassi) Goid.	1	*Macrophomina phaseolina* (Tassi) Goid.	1
	Rhizoctonia solani Kuhn	1,2,5,7	*Stachybotrys atra* Corda	1
	Unidentified sclerotial fungus	1,2	Unidentified sclerotial fungus	1,2
61. *Solanum melongena* L. (EGG PLANT)	*Alternaria alternata* (Fr.) Keissler	4	*Aspergillus flavus* Link ex Gray	1,2,4,6
	Aspergillus flavus Link ex Gray	4	*A. fumigatus* Fres.	1,4
	A. niger van Tieghem	4	*A.niger* van Tieghem	1,2,6
	A. terreus Thom	4	*A. terreus* Thom	4
	Fusarium oxysporum Schlecht. emend. Snyd. & Hans	1,2,6	*Fusarium oxysporum* Schlecht. emend. Snyd. & Hans	1,2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4
			Macrophomina phaseolina (Tassi) Goid.	4

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Macrophomina phaseolina (Tassi) Goid.	1,2,4,6	*Myrothecium roridum*	4
	Rhizoctonia solani Kuhn	1,2,4,6	*Rhizoctonia solani* Kuhn	1,2
	Verticillium chlamydosporium Goddard	1		
62. *Solanum nigrum* L. (BLACK NIGHTSHADE)	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B Ellis.	2	*Aspergillus flavus* Link ex Gray	2
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*A.niger* van Tieghem	2
	Rhizoctonia solani Kuhn	2	*Drechslera australiensis* (Bugni) Subram & Jain ex M.B.Ellis.	2
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2
			Rhizoctonia solani Kuhn	2
63. *Solanum surrenttense* Burm f.	*Aspergillus flavus* Link ex Gray	5	*Alternaria alternata* (Fr.) Keissler	5
	Fusarium oxysporum Schlecht. emend. Snyd. & Hans	5	*Aspergillus flavus* Link ex Gray	5
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5	*A. nidulans* (Eidam) Winter	5
	Macrophomina phaseolina (Tassi) Goid.	5	*A. niger* van Tieghem	5
			A. sulphureus (Fres.) Thom. & Church	5
			A. terreus Thom	5
			Chaetomium flavum Omvik	5
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5
			Myrothecium roridum Tode	5
			Penicillium raistrickii Gilman & Abbott	5
UMBELLIFERAE				
64. *Coriandrum sativum* L. (CORIANDER)	*Aspergillus flavus* Link ex Gray	2	*Alternaria alternata* (Fr.) Keissler	7
	A. niger van Tieghem	2,7	*Aspergillus flavus* Link ex Gray	2
	Curvularia lunata (Wakker) Boedijn	2	*A. niger* van Tieghem	2,7
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	2	*A. nidulans* (Eidan) Winter	2
			A. terreus Thom	2

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	D. halades (Drechslera) Subram. & Jain ex M.B. Ellis.	7	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,7
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,7	*Macrophomina phaseolina* (Tassi) Goid.	2
	Macrophomina phaseolina (Tassi) Goid.	2	*Stachybotrys parvispora* Hughes	7
	Unidentified white sterile mycelium	7	Unidentified sclerotial fungus	2
65. *Daucus carota* L. ssp. *sativus* (Haffm.) Acrang (CARROT)	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*Alternaria alternata* (Fr.) Keissler	2
			Aspergillus flavus Link ex Gray	2,6
			A. niger van Tieghem	2,6
			A. nidulans (Eidam) Winter	2
			A. terreus Thom	2
			Cladosporium sp.	2
			Fusarium semitectum Berk. & Rav.	6
			F. solani (Mart.) Appel & Wollenw. Emend. Snyd. & Hans	2
			F. oxysporum Schlecht. emend. Snyd. & Hans	2
			Macrophomina phaseolina (Tassi) Goid	6
			Stachybotrys atra Corda	5
			Unidentified sterile fungus	2
			Unidentified yeast	2

1 = Karachi University Campus, **2** = Memon Goth, **3** = Darsano Chano, **4** = Shah Faisal Colony, **5** = Hub, **6** = Kathor, **7** = Gharo, **8** = Thatta

with additional roots until the total volume of soil and water become 20 mL, assumed to be 1:10 dilution. From this other dilutions 1:100, 1:1000, 1:10,000, 1:100,000 were made. One mL aliquot from each of the last two highest dilutions were poured in sterilized petri plate containing potato dextrose agar (PDA) incorporated with penicillin (100,000 units/L) and streptomycin (0.2 g/L) to check bacterial growth. Plates were incubated for 5 days at room temperature (25–30° C) under 12 hours light and dark conditions. Fungi that grew and sporulated on plates were identified with reference to Barnett and Hunter (1998), Dix and Webster (1995), Domsch et al. (1993) and Nelson et al. (1983). Special attention was paid towards the occurrence of root infecting and well known biocontrol agents like *Trichoderma*, *Paecoilomyces lilacinus*, *Verticillium chlamydosporium*. Fungi that did not show morphological characters were included as unidentified.

Isolation of Fungi from Rhizoplane

Roots were washed under running tap water. Tap and lateral roots were cut into 1 cm long pieces, washed with sterilized water and transferred onto PDA plates containing penicillin (100,000 units/L) and streptomycin (0.2 g/L). Plates were incubated for 5 days at 28° C. Fungi grown on plates were identified as described above.

RESULTS AND DISCUSSION

The ecological relationships between host, pathogen and population of soil microbes have been represented by a triangle of interactions (Subba Rao 1977). Root infection by a parasite must be affected and often decisively by the microbial activity of the root surface and rhizosphere microflora (Abawi & Widmer 2000; Boland & Kuykendall 1998; Filion et al. 2004; Manka & Kacprzak 1999; Marschner et al. 2002; Subba Rao 1977; Whipp 2001). In the present study, 57 species of fungi belonging to 23 genera were isolated and identified from rhizoplane and rhizosphere of 65 plant species (Table 2). These comprised 58 genera within 19 families collected from from Sindh and Baluchistan (Table 2). Most of the fungi isolated from rhizosphere and rhizoplane belonged to ascomycota and fungi imperfecti. Few genera belonged to zygomycotina and mycelia sterilia. Host plants are arranged under their families and associated fungi.

A greater number of fungi was isolated from the rhizosphere than from the rhizoplane. In rhizosphere, *Aspergillus flavus* and *A. niger* were predominant along with *Fusarium solani* (Table 2). Population of aspergilli like *A. flavus*, *A. niger* and *A. terrus* was high as compared to other fungal species (data not presented). It is interesting to note that *A. niger* was found in the rhizosphere of the all the members of families Cucurbitaceae, Fabaceae, Solanaceae and Umbliferae. Various studies have also reported the occurrence of greater num-

ber of fungal species in rhizosphere than in rhizoplane (Abawi & Widmer 2000; Curl & Truelove 1986; Dix & Webster 1995; Frey et al. 1999; McLean & Huhta 2002)). It has been shown that microbial population is stimulated in rhizosphere (Manka & Kacprzak 1999). Organic and inorganic substances exuded from roots and sloughed off root cells enhanced the microbial population in the region (Tate 1995). Microorganisms in agricultural soils are known to exert profound influences on the soil fertility status as well as on the suppression of soil-borne plant diseases (Kennedy & Smith 1995). In fact, the health of soil can be defined in terms of its microbiological capacity to counteract (suppress) the activity of plant pathogenic or plant deleterious microorganisms (Katan 2002; van Bruggen & Semenov 2000). It is well known that some soils are naturally suppressive to some soil-borne plant pathogens such as *Fusarium oxysporum*, *Pythium* and *Phytophthora* species and this suppression relates to both physicochemical and microbiological features of the soil (Whipps 1997; 2001). Importantly, a soil that is suppressive to one pathogen is not necessarily suppressive to another, and so specificity in soil-plant-microbe interactions for disease suppression exists (Filion et al. 2004; Katan 2002; Marschner et al. 2002; Shiomi et al. 1999). Modern methods for analyzing microbial community structures may prove particularly valuable to help define the key organisms or groups of organisms responsible for such natural suppression as well as for monitoring the spread and impact of introduction of specific biocontrol agents or other management practices on natural microbial populations (Gamo & Shoji 1999; Smit et al. 1999; Postma et al. 2000; Whipps 2001).

In the rhizoplane, root-infecting fungi like *Fusarium solani*, *Drechslera australiensis*, *Macrophomina phaseolina* and *Rhizoctonia solani* were found to be predominant. *Aspergillus flavus* and *A. niger*, *Alternaria alternata*, *Chaetomium globosum*, *Curvularia clavata* and *Fusarium oxysporum* showed an intermediate frequency while remaining isolates were found in low frequency (Fig. 1; Table 2). Among the species of *Aspergillus* encountered frequency of *Aspergillus flavus*, *A. niger* was higher than for other fungi except *F. solani*. This is presumably due to their high sporulating ability and tolerance for different physico-chemical conditions of soil (Domsch et al. 1993). It is interesting to note that *Fusarium solani* was found predominant in both the rhizosphere and rhizoplane of most of the plant species reflecting their high competence in both rhizosphere and rhizoplane of different plant species in different ecological conditions. Characteristics like resistant nature, tolerance to a wide range of moisture, pH and temperature, and parasitic as well as saprophytic mode of life make *F. solani* ubiquitous (Hussain et al. 1966). *Fusarium solani* produces many antibiotics and mycotoxins (Whipps 1997, 2001). *Fusarium solani* is also reported to possess cytotoxic effect on root knot nematode *Meloidogyne javanica*, besides parasitizing its eggs (Hameed et al. 2001). These characteristics play a significant role in its establishment in the rhizosphere and rhizoplane. *Chaetomium*

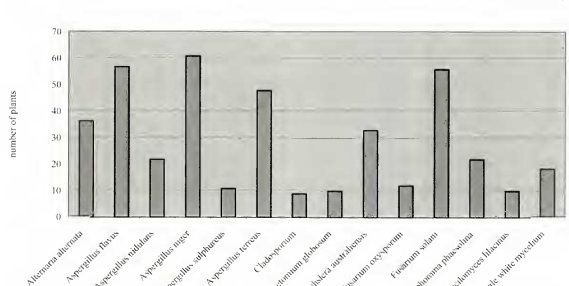

Fig. 1. Major fungi isolated from rhizosphere of 65 plants showing their incidence on hosts.

globosum, *C. indicum* and *Macrophomina phaseolina* had a moderate frequency while *Aspergillus fumigatus*, *A. nidulans*, *Fusarium moniliforme*, *F. oxysporum*, *F. semitectum*, *Penicillium* spp., showed low frequency (Table 2). *Penicillium* spp. are generally abundant in soil and are often among the readily isolated species (Qureshi & Khan 1971). There are reports that *Penicillium*, *Trichoderma*, and *Cladosporium* are most common genera associated with rhizosphere of resistant varieties of flex to *Fusarium* wilt, while *Alternaria*, *Cephalosporium*, *Fusarium*, *Helminthosporium* and *Verticillium* were relatively common in the rhizosphere of susceptible variety (Subba Rao 1977). Chesters and Parkinson (1959) reported that *Penicillium* spp. are abundant in the rhizosphere of very young roots while in older roots they are replaced by members of family Hypocreaceae (e.g. *Fusarium*) and family Dematiaceae (e.g. *Alternaria* and *Drechslera*). In this study six sterile mycelium and one ascomycetous fungi were not identified. Sterile mycelium did not produced reproductive structure on agar media. Might be they required special condition for reproduction. Oligonucleotide finger printing of rRNA genes for analysis of fungal community in soil (Valensky et al. 2002) would be helpful for their identification. It is interesting to note that, in general cultivated plants and common weeds of families Fabaceae and Compositae showed more fungi than wild plants. Presumably roots exudates of cultivated plants and common weeds are more attractive to microbes than exudates of wild plants.

In the present study well known biocontrol agents like *Trichoderma* spp., and *Paecilomyces lilacinus* were found in very low frequencies. Species of *Tri-*

choderma are known to produce antibiotics (Tate 1995; Domsch et al. 1993). Their fewer occurrences reflect their weak competence in the rhizosphere, presumably their sensitivity to metabolites of competeting microorganisms. There are reports that a bacterium with a high level of resistance to a range of antibiotics is more likely to be successful competitor in the rhizosphere than a bacterium producing large quantities of highly active antibiotics but has a marked sensitivity to even a single antibiotic molecules (Bazin et al. 1990). Multiple microbial interactions involving bacteria and fungi in the rhizosphere are shown to provide enhanced biocontrol in many cases in comparison with biocontrol agents used singly (Boland & Kuykendall 1998; Whipps 1997, 2000). A wide range of fungi with antagonistic activity against root pathogens are discovered each year. However, ecological success of the antagonist on the plant roots is governed by its ability to colonize and utilize substrates on plant root surface, allowing it to compete effectively with pathogens and other competitive microorganisms. Otherwise the success of a biocontrol agent with poor rhizosphere competence seems very remote.

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